inter.noise 2010
noise and sustainability
13-16 June 2010 . Lisbon . Portugal
www.internoise2010.org

A Quiet Area Accessibility Metric for the Southampton Urban Agglomeration

J. Battaner-Moro[1], C. Barlow[2], P. Wright[3]

Southampton Solent University
[1]juan.battaner-moro@solent.ac.uk
[2]christopher.barlow@solent.ac.uk
[3]paul.wright@solent.ac.uk

Abstract
This study proposes a new metric that characterises accessibility to "quiet areas", as defined by the Environmental Noise Directive (END), in urban agglomerations by using Geographical Information System software in conjunction with END noise mapping results. The metric methodology is shown and it is used to determine lack of access to quiet spaces in social disadvantaged areas in the city of Southampton, United Kingdom. The results can help urban planners to identify districts that need better provision of tranquil spaces and to enforce measures to protect existing quiet areas. The study concludes with a description of the implementation of the quiet area accessibility metric in open source internet urban mapping tools.

Keywords: Noise metrics, quiet areas, environmental justice.

1 Introduction

Noise Action Plans have recently been introduced in England to address the management and noise issues and effects in urban agglomerations under the terms of the Environmental Noise (England) Regulations 2006 as amended. These regulations transpose Directive 2002/49/AC relating to the Assessment and Management of Environmental Noise, commonly referred to as the Environmental Noise Directive or END.

The Noise Regulations require that Action Plans for agglomerations include provisions that aim to identify Quiet Areas and protect them from an increase in noise (from those sources covered by the END). Quiet Areas are to be formally identified by a governmental competent authority in consultation with local authorities at each agglomeration.

The English Government has recognized that open spaces contribute to the quality of urban life. Open spaces that are designated as Quiet Areas will get a status enhancement. Local

authorities will be then mandated to adopt policies to protect the quietness of these open spaces, integrating them with wider policies to attain the goal of sustained development.

The recognition of the importance of Quiet Areas as an enhancement to the urban environment leads to the question of how much of the urban population of a given agglomeration, with a particular environmental noise environment, can benefit from access to them. In particular, do the most vulnerable people from a social point of view have the same level of access to quiet open spaces as the most advantaged social groups?

2 Social deprivation and noise exposure

Poverty has been defined as not having enough financial means to meet needs. On the other hand, deprivation refers to unmet need, which is caused by a lack of resources of all kinds, not just financial. In the context of this research we will be referring to “tranquillity deprivation” as an indicator of social disadvantage.

2.1 Deprivation indices in England

In order to identify the most disadvantaged areas in England deprivation indices are used so that resources can be appropriately targeted.

To be able to measure deprivation at a smaller spatial scale, studies have been conducted at a so-called Lower Super Output Area (LSOA) level.

Super Output Areas (SOAs) are a unit of geography used in the UK for statistical analysis. They are developed and released by Neighbourhood Statistics.

SOAs were created with the intention that they would not be subject to frequent boundary change. This makes SOAs more suitable than other geography units (such as wards) because they are less likely to change over time, and thus SOAs are more suitable to change over time analysis.

Lower SOAs have a minimum population of 1000, and mean population 1500.There are 34,378 LSOAs in England and Wales.

The Indices of Deprivation 2007 for England take into account seven domains of deprivation at LSOA level [1]:

- Income deprivation
- Employment deprivation
- Health deprivation and disability
- Education, skills and training deprivation
- Barriers to housing and services
- Living environment and deprivation
- Crime

Each domain is assessed using a number of indicators, such as household overcrowding, criminal damage, houses without central heating and so on. 38 indicators are used in total, but none of these indicators take into account environmental noise pollution.

2.2 The impact of environmental noise exposure on urban population

It has been widely document that environmental noise has a cumulative adverse effect on health [2]. It is now accepted that continuous noise exposure above certain levels correlate with an increase in annoyance and sleep disturbance. From a social point of view it has been shown that environmental noise near schools can have a detrimental effect on the academic attainments of primary school children for example [3].

In spite of this, environmental noise exposure is not used as an indicator for English social deprivation statistics.

Are the most vulnerable people in cities more likely to live in areas with a high environmental noise exposure? Subjectively it would appear that this is not necessarily the case. One needs only to walk along a very affluent area of London such as Knightsbridge to see that it suffers from very high levels of road traffic noise.

Therefore it would appear that high levels of traffic noise do not deter affluent individuals to buy property in desirable parts of a city. There may be several reasons for this. For example wealthy people can afford to spend extra money on high standards of acoustic insulation, they may own other properties in quieter locations in which they can retire when a more tranquil environment is desirable or there may be a “quiet space”, such as a park, in the vicinity of their property. Following our previous example, one of the reasons that Knightsbridge is such a desirable location in London is the vicinity of Hyde Park.

So the question regarding the relationship between social disadvantage and exposure to noise should be reassessed. It could be said that “tranquillity deprivation” reflects the lack of resources to mitigate noise exposure, and these resources are effective noise insulation at home and easy access to quiet spaces.

English deprivation statistics do not take into account the quality of noise insulation. However, the “Living Environment and Deprivation” domain include data on “social and private housing in poor condition” [1], which may correlate well with poor acoustic insulation. Thus, a basic assessment of tranquillity deprivation for urban agglomerations in England would only require a quiet space accessibility indicator.

3 Quiet Areas and the European Noise Directive

Through the realisation that noise pollution is still a worsening problem; the European Union has started to coordinate policies that aim to tackle this problem. It has stipulated continuous noise monitoring in urban agglomerations, implemented public information campaigns and requested Local Authorities to produce long term noise action plans.

The European Parliament and the Council adopted Directive 2002/49/EC relating to the assessment and management of environmental noise. Its general aim being 'to define a common approach intended to avoid, prevent or reduce on a prioritised basis the harmful effects, including annoyance, due to exposure to environmental noise'.

3.1 Definition of a Quiet Area

Based on the recommendations from the Department for Environment, Food and Rural Affairs, Quiet Areas are identified in agglomerations based on the selection of an appropriate, existing dataset, e.g. public and open spaces in the UK, and subsequent

reduction of the dataset by the successive application of filters related to for example, land type, a pre-determined noise level (at least part of the candidate area must fall within the less than 55dB L_{day} noise band, as determined from the first round of noise mapping) and a minimum area (the candidate area must be at least 9 hectares) [4].

3.2 Southampton parkland

Southampton is the largest city in the county of Hampshire on the south coast of England. It lies at the northernmost point of Southampton Water at the confluence of the River Test and River Itchen, which divides the city into an eastern and a western half, with the River Hamble joining to the south of the urban area. The local authority is Southampton City Council.

For the purposes of the END, the city is part of the Southampton Agglomeration, which also comprises Eastleigh to the North and other smaller conurbations totalling 295,000 inhabitants. This paper will focus on the city of Southampton exclusively.

Southampton's parks make it the one of the greenest cities in Southern England. Close to the Old Town are seven formal parks which were originally common land in medieval times. The large 133 hectares Common, located relatively close to the city centre, is designated a Site of Special Scientific Interest.

Other large parks are Mayfield Park and Riverside Park (Figure 1). Table 1 summarises all parks in Southampton sorted by their extension.

The first five parks in Table 1 are larger than nine hectares. Unfortunately the results of the first round of END for Southampton do not include noise exposure modelling for Southampton Municipal, Riverside Park and Mayfield Park (Figure 2). At the time of writing this the authors could not establish the reasons why three of the largest parks in the city were left out from the L_{den} calculations.

Table 1 – Southampton city parks

Name	Extension (hectares)
The Common	133.5
Southampton Municipal	52.0
Riverside Park	26.9
Mayfield Park	26.2
Peartree Green	12.1
Mansel Park	10.0
Green Park	6.6
Andrews Park	6.1
Hoglands Park	5.2
Mayflower Park	4.6
Freemantle Common	3.6
Palmerston Park	3.3
Hinkler Green	2.9
Watts Park	2.6
Houndwell Park	1.8
Freemantle Lake Park	1.7
St James Park	1.5
Queen's Park	1.5

From these three parks that have no END data available, Riverside Park may not be considered a Quiet Area due to its location directly under the noise footprint of Southampton-Eastleigh Airport and its proximity to the M27 motorway. Southampton Municipal's is mostly occupied by a golf course and other sport fields. Mayfield Park however is located in an area of relative low noise and could be considered a candidate for "Quiet Area" designation.

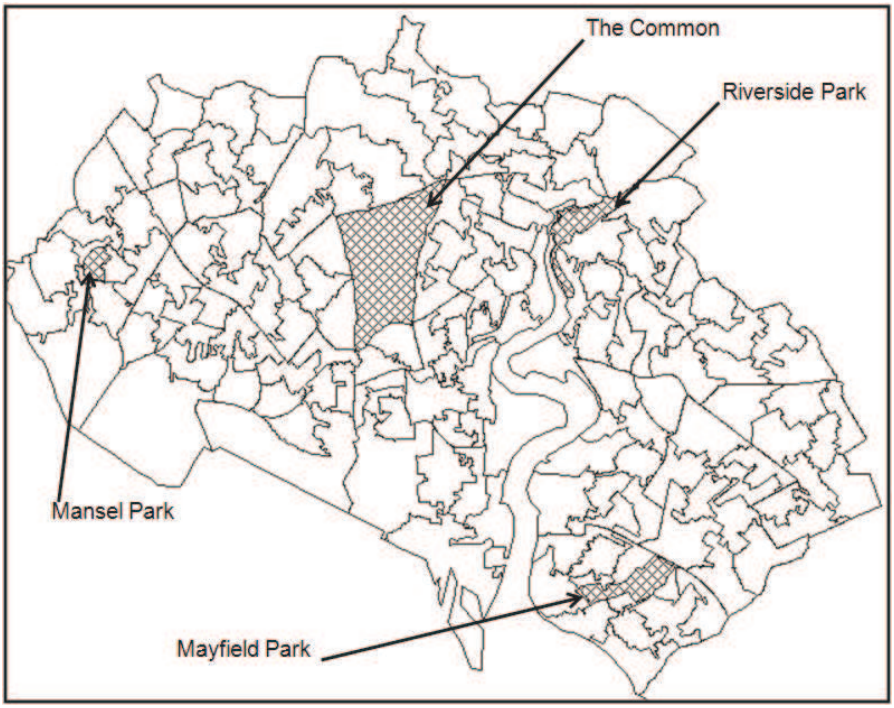

Figure 1 – Southampton city Lower Super Output Area divisions and main parks

There exists END noise data available for three parks larger than 9ha: the Common, Mansel Park and Peartree Green. Mansel Park's L_{den} due to road traffic is larger than 55dB. Peartree Green's L_{den} is also larger than 55dB but in this case rail noise is the dominant source. This leaves the Common as the clear candidate for "Quiet Area" designation.

Therefore in this paper the Common (in the western half of the city) and Mayfield Park (in the eastern half) will be considered Quiet Areas for the purpose of calculating accessibility using the proposed metric.

3.3 First round END results

Figure 2 shows modelled L_{den} road noise levels for Southampton. The areas not modelled are shown in white and are not populated. Crucially, some of these areas (denoted by red arrows) are parks that could be candidates for Quiet Area designation.

3.3.1 Calculating mean noise exposure for each LSOA

Initial noise data was sourced from the DEFRA noise model. The resulting GIS file took the form of semi-contiguous regions of modelled noise data, which, in itself was difficult to disaggregate back into the individual 10x10m grid used to model the data. Therefore, the relevant data were forced into a 100x100m grid, the decreased resolution being due to processing restrictions within our GIS software package (MapInfo). An average for each 100x100m square was calculated from the initial noise data. This data was then used to calculate a mean noise level per LSOA (figure 3).

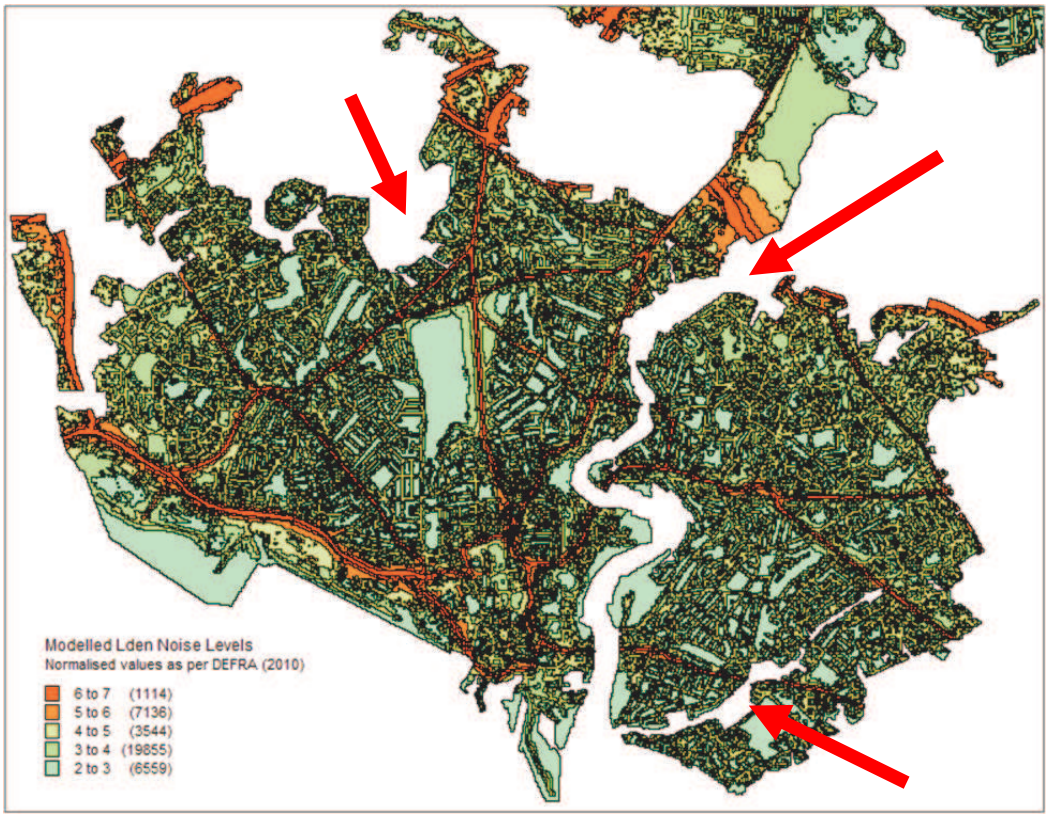

Figure 2 – Road noise L_{den} for Southampton. Arrows point to parks not modelled (Southampton Municipal, Riverside and Mayfield). See Table 2 for L_{den} value bands.

Table 2 – Noise bands

Grid Code	L_{den} Level (dB)
7	≥ 75
6	70.0-74.9
5	65.0-69.9
4	60.0-64.9
3	55.0-59.9
2	< 55

With this data in hand it is possible to search for correlations with any deprivation index. However noise exposure alone (Figure 3) is not a deprivation quality, but the lack of means to combat noise exposure is.

4 Accessibility to quiet spaces

4.1 The need for an accessibility metric

As it has been mentioned, the detrimental effect that noise has on the public is not taken into account in social deprivation indices. We propose to use the lack of access to quiet spaces relative to noise exposure as an indicator of deprivation.

This indicator may help planners in identifying the value of Quiet Areas in the urban social context and may be used as a tool to implement action plans as mandated by the END.

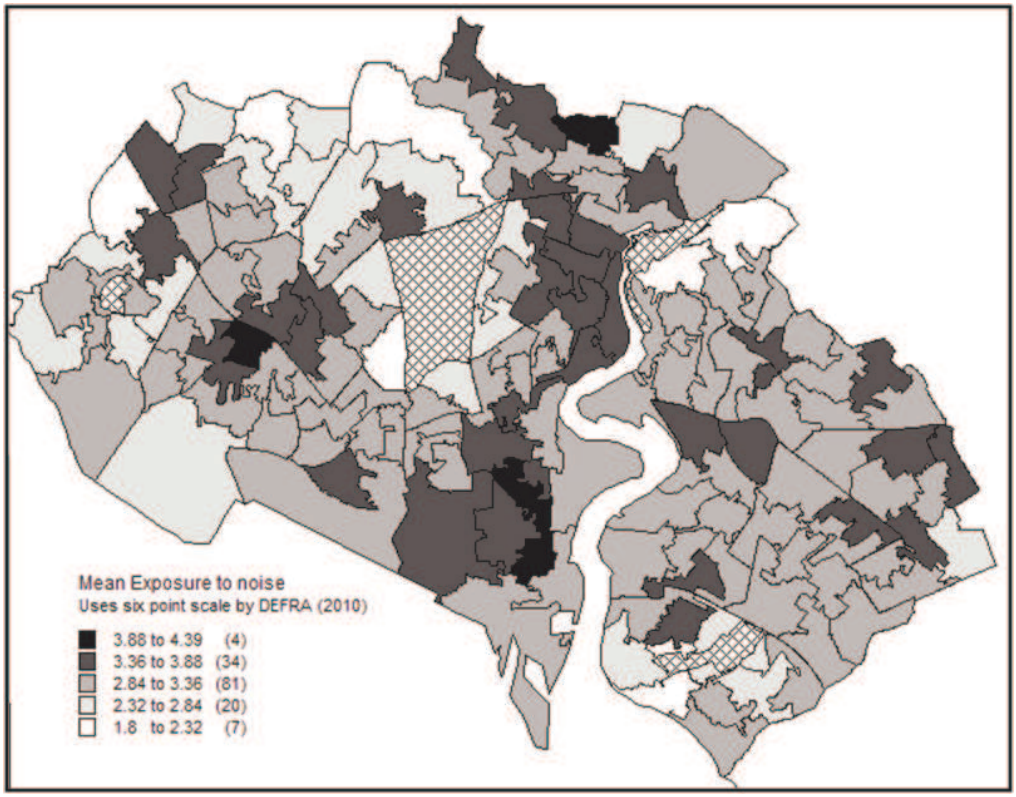

Figure 3 – Calculated Mean Noise Exposure at LSOA level (darkest areas are noisier, main parks also shown)

4.2 Combined noise exposure and accessibility metric

In order to combine noise exposure data with accessibility the distance to the nearest Quiet Area (either the Common or Mayfield Park) were calculated for every LSOA.

The *accessibility level* is then computed using the following formula:

$$L_{acc}=10\log(D/D_{min}) \quad (1)$$

Where D is the distance to the nearest Quiet Area from the geographical centroid at each LSOA and D_{min} is the shortest from all distances D. The *quiet area accessibility* indicator is then calculated by taking the average of L_{den} + L_{acc} for each LSOA. The results are shown in Figure 4.

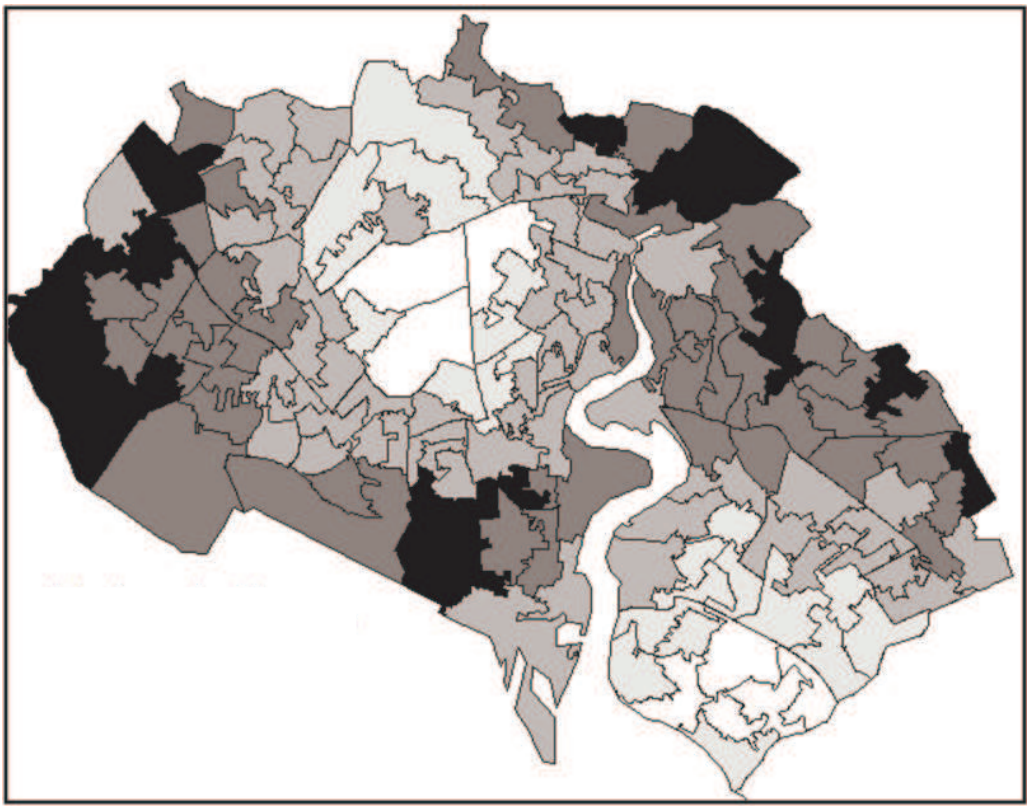

Figure 4 – Calculated quiet area accessibility indicator at LSOA level (darker areas have worst accessibility)

5 Correlations with deprivation indicators

All social data was sourced through the Office of National Statistics (ONS), from their 2007 dataset relating Indices of Deprivation, available at <http://www.neighbourhood.statistics.gov.uk> and [5].

The correlation test used is a Spearman's Rank Correlation (ρ) test, corrected for ties. All variables tested for rank correlation with the proposed quiet area accessibility indicator:

Table 3 – Rank correlations with quiet area accessibility indicator

Variable correlated against accessibility indicator	ρ
Mean exposure	0.420**
Score of housing in poor condition	0.063
Score of health, deprivation and disability	-0.291**
Score of Multiple Index of Deprivation	-0.354**

** denotes significant correlation at ρ<0.01, with a two tailed test.

The correlation with mean exposure is high, perhaps, not unsurprising, given how the indicator has been defined. The correlation with housing might be expected to be positive, but this is complicated by the fact that mean exposure and deprivation are not correlated (ρ = -0.145), and deprivation (Figure 5) and housing condition (Figure 6) are highly significantly correlated (ρ = -0.486).

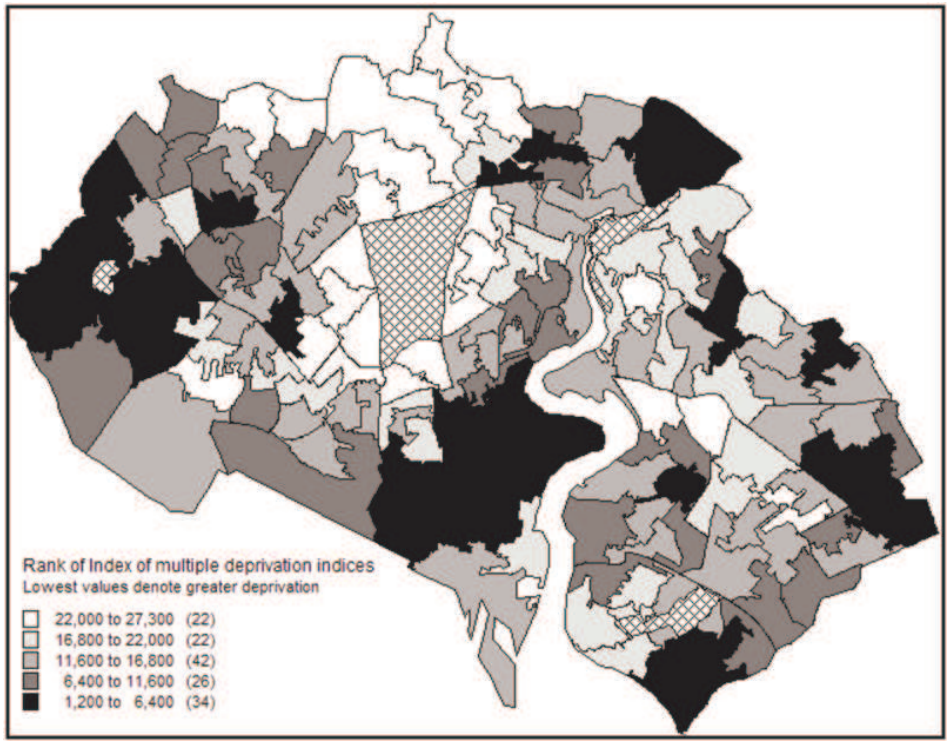

Figure 5 – Index of multiple deprivation at LSOA level (darker areas have greater deprivation)

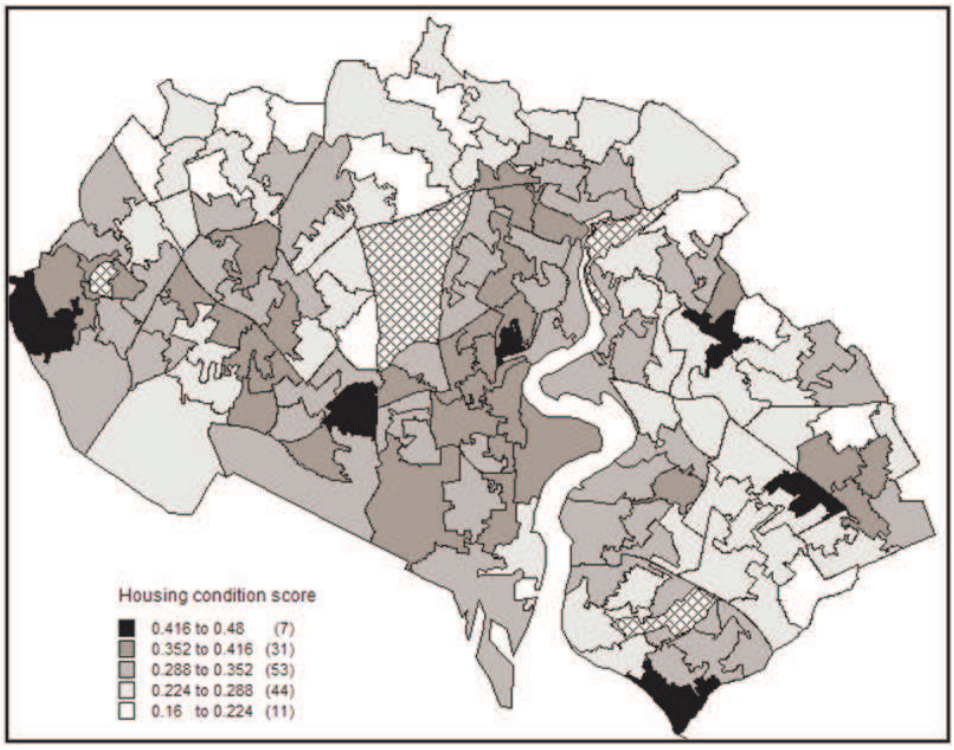

Figure 6 – House in poor condition indicator at LSOA level (darker areas have worst condition)

This lack of correlation is somewhat surprising at face value, yet is understandable given the urban development of Southampton, with relatively affluent suburbs being fringed by major

roads, such as the M3, M27, and M271. Also, since distance from Mayfield Park is also factored into our indicator, areas with relatively poor housing, such as Woolston, possibly benefit from their geographical location i.e. being relatively close to a 'quiet area'. However, the highly significant negative correlations the accessibility indicator with deprivation in its broad sense and health deprivation, suggest that there is some concern that those who are most deprived socially experience a les tranquil environment.

6 Conclusions

This paper has proposed a quiet area accessibility metric which could be used in conjunction with house noise insulation statistics to define a tranquillity deprivation indicator. This indicator could be useful to urban planners to determine areas lacking a healthy acoustic environment which could benefit from the creation of nearby quiet open spaces.

It has been shown that the quiet area accessibility indicator has a significant correlation with house in poor condition indicator and the multiple deprivation index in Southampton.

In future work other English urban spaces will be investigated to assess the robustness of the quiet area accessibility indicator and its suitability for inclusion in social deprivation statistics.

Acknowledgments

The authors wish to acknowledge their gratitude to Stephen Parkinson at DEFRA for providing the END noise exposure data for the Southampton urban Agglomeration.

References

[1] Noble M. *et al*. The English Indices of Deprivation 2007, Department for Communities and Local Government. 2008.

[2] Ohrstrom E. *et al.*, Effects of road traffic noise and benefit of access to quietness, *J. Sound & Vib, Vol* 295**,** 2006, pp40-59.

[3] Shields B. M. and Dockrell J.E., The effects of environmental and classroom noise on the academic attainments of primary school children, *J. Acoust. Soc. Am.* Vol 123(1), 2006, pp 133-143.

[4] Research into Quiet Areas. Recommendations for identification. DEFRA. 2006.

[5] A Study of the 2007 Index of Multiple Deprivation for the Hampshire County Council Area. Hampshire County Council. 2008.